

How Does Mediterranean Basin's Atmosphere Become Weak Moisture Source During Negative Phase of NAO:

Use of AIRS, AMSR, TOVS, & TRMM Satellite Datasets Over Last Two NAO Cycles to Examine Governing Controls on E - P

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The Mediterranean Sea is a noted 'concentration' basin in that it almost continuously exhibits positive evaporation minus precipitation (E - P) properties -- throughout the four seasons and from one year to the next. Nonetheless, according to the ECMWF Era-40 48-year (1958-2005) climate reanalysis dataset, for various phases of the North Atlantic Oscillation (NAO) when the pressure gradient between Portugal and Iceland becomes either very relaxed (large negative NAO-Index) or in transition (small positive or negative NAO-Index), the atmospheric moisture source properties of the basin become weak, at times even reversed for several months (i.e., negative E - P). This behavior poses numerous questions concerning how and why these events occur. Moreover, it begs the question of what it would take for the basin to reach its tipping point in which P would exceed E throughout the rainy season (some six months) on an annually persistent basis -- and the sea would possibly transform to a recurring "dilution" basin.

This talk investigates these questions by: (1) establishing over a period from 1979 to present, based on detailed analyses of satellite retrieval products from a combination of NASA-AQUA, NOAA-LEO, NASA/JAXA Scatterometer, and NASA-TRMM platforms, plus additional specialized satellite data products and ancillary meteorological datasets, the actual observation-based behavior of E - P, (2) diagnosing the salient physical and meteorological mechanisms that lead to the weaker E - P events during the analysis period, partly based on analyzing surface and upper air data at discrete stations in the western and eastern Mediterranean -- while at the same time evaluating the quality of the ERA-40 data over this same time period, (3) conducting GCM and high-resolution regional modeling experiments to determine if perturbed but realistic meteorological background conditions could maintain Mediterranean as a "dilution" basin through the October to March rainy season on annually recurring basis, and (4) investigating how such conditions might modify important internal and external climatic processes known to be closely related to the dynamical, thermal, and hydrological properties of the basin (e.g., drought frequency over Iberian peninsula, rainfall accumulation within Sahel, alteration of Levantine branch of east-west aligned open thermohaline cell, and modification of warm-salty intermediate flow through Gibraltar straight into North Atlantic).

Thus, the governing hypothesis guiding this research is that the Mediterranean basin experiences intermittent episodes of decreased E - P flux during periods when the cyclone frequency is elevated and torrential rains persist -- *weather conditions for which the evaporation is normally large over relatively warm basin-wide SSTs* -- thus countering the tendency for large positive values of E - P, stemming from various anticipated mechanisms, including (a) relatively cooler basin-wide SSTs from lowered basin heat contents (which would decrease E), (b) depressed moisture fluxes associated

with decorrelations between cyclone surface wind gust deviations and constant-flux-layer moisture gradient deviations which (would decrease E), (c) relatively small vertical wind shear conditions thus permitting invading cyclones to be dynamically maintained (which would increase P), and (d) enhanced moisture fluxes into basin produced by eastward transits of remnant Atlantic tropical cyclones which would enhance precipitation intensity within basin from relatively weaker cyclones (which would increase P) -- a set of conditions which would enable E - P to approach zero and even drop below zero -- in essence, transforming the Mediterranean momentarily (one to several months) from a "concentration" to "dilution" basin.

The diagnostic satellite analyses have produce results never realized in the past literature concerning climate processes in the Mediterranean basin, a literature which has depended strictly on convectional *in situ* observations [as documented in a current (2006) Mediterranean Climate Variability book drawn from documents produced by the recently established MEDCLIVAR Program], while the modeling experiments address questions deserving attention in the context of global climate change -- recognizing that the Mediterranean on a historical basis has experienced both extreme drying (e.g., complete drying some 5.6 million years ago during the Messinian event) and extreme flooding (repeated events within the catchment over at least two millennia). It is also stressed that beyond the scientific issues, because of the relevance to water resources, the answers to these questions are of manifest concern to the body of 21 nations surrounding the Mediterranean basin and to the some 440 million human population residing within its domain.